

to certain species and genera. When, however, these great difficulties are taken into account, it must be allowed that the author has fulfilled his task in a highly creditable and satisfactory manner.

And as regards nomenclature, classification and the splitting-up of certain old, unwieldy generic groups like the squirrels into divisions of smaller size, Mr. Sclater is well abreast of modern ideas. One of the most noticeable of these modern changes in classification is the transference of the so-called Cape jumping-hare—the spring-haas of the Boers, from its old association with the jerboas—to a position near the cane-rat and the porcupines. Nor is this all that is noteworthy in Mr. Sclater's remarks on the creature; for we are told that, in spite of the huge bounds it takes, "it is never very rapid in its movements, and can be easily overtaken." This information we have not found given in any of the other works to which we have turned. It is a matter for regret that the portrait of the spring-haas, like many of the other figures in the book, has not been executed in a more satisfactory style.

An old error—to wit, that it burrows—in connection with the cane-rat is also corrected, mainly on the evidence of the late Prof. Peters and Captain Drummond.

Among the most curious and interesting of all the smaller mammals of South Africa are the elephant-shrews, or jumping shrews, and the golden moles, and of each of these Mr. Sclater gives an excellent account, both as regards bodily characteristics and habits, although further observations are stated to be required with regard to the mode of life of the last-mentioned animal.

"The golden mole," writes the author, "is exceedingly common in gardens, where it makes runs in all directions in search of the worms and grubs on which it lives. Although generally supposed to be destructive, it is really a great aid to the gardener, as it destroys quantities of larvæ, especially those of a certain gamma moth. . . . A certain amount of mischief, however, is done by the mole in pursuit of its prey by disturbance of roots and freshly-sewn seeds."

In addition to the Rodentia, Chiroptera and Insectivora, the present volume also includes the South African Cetacea and Edentata. Among the cetaceans special interest attaches to the author's description of a specimen of the lesser sperm-whale recently taken in Table Bay, as the external characters of this rare whale have been hitherto very imperfectly known. Of the specimen in question Mr. Sclater gives a sketch, which shows the characteristic shark-like mouth and small dorsal fin. Certain differences in size which have been thought to indicate specific distinction are, in the author's opinion, probably due to difference of sex in the individuals which have from time to time been examined.

The aard-vark and the pangolin Mr. Sclater, although with some hesitation, still retains in the same order with the typical South American Edentata. And it must be confessed that certain observations which have recently been made with regard to the myology of these creatures tends, so far as it goes, to justify this conservatism. Whether there really is any close relationship between the two groups is a question of the very highest importance in regard to certain views that have been recently expressed in favour of a former connection between Africa

and South America. And it would greatly help matters if a decisive answer could be given on this point.

Mr. Sclater may be congratulated on the completion of a very important and valuable work. R. L.

### INFINITESIMAL GEOMETRY.

*Einführung in die Theorie der Curven in der Ebene und im Raume.* By Dr. Georg Scheffers. Pp. viii + 360. (Leipzig: Veit and Co., 1901.) M. 10.

THIS volume is the first of two which will make a complete work under the title "Anwendung der Differential- und Integral-Rechnung auf Geometrie." The subject-matter of the two volumes may be said to be, roughly, the infinitesimal geometry of curves and surfaces respectively. The first volume is divided into three sections, dealing with plane curves, curves in space, and developable surfaces. The first section does not attempt to be a complete exposition of the subject, and must be regarded as an introduction to what follows, intended to accustom readers who are already well grounded in differential and integral calculus to the style and methods which are employed later. The theory of the curvature of plane curves is based on the definition of contact of an assigned order, which is explained with great exactness. The differential invariants of a curve for the group of movements in the plane are fully investigated, and their properties established in an elementary manner without introducing notions of groups or partial differential equations. Envelopes, evolutes, singular points, and the geometrical significance of differential equations of the first order and degree are discussed shortly. In connection with the trajectories of a family of curves, the problem is completely solved of finding all curves for which the product of the normal and radius of curvature is constant. The remainder of the first section is devoted to an explanation of curvilinear coordinates.

The second section contains a thorough and systematic account of the curvature, torsion, and allied theory of curves in space. The dual interpretation of an orthogonal substitution of coordinate as a change of frame of reference and as a movement in space is first carefully explained, and the theory of the intrinsic properties of curves is built upon it. Particularly interesting are the discussions of the differential invariants and of the integration of the intrinsic equations of a curve, in the course of which an elementary account of Riccati's equation is given. Conditions for contact of an assigned order are carefully laid down, and from them the relations between a curve and its osculating circle and helices are deduced; in particular we have the interesting result that the axes of all osculating helices at any point generate a cylindroid.

In the third section the main properties of the surface generated by the tangents to a curve are established. The general ruled surface is introduced in order to provide a rigorous investigation of what is meant by saying that consecutive generators intersect. The remainder of the section is occupied with various loci connected with a given curve, such as evolutes, involutes, parallel curves, polar surface, rectifying surface, etc. The text ends with a short account of minimal lines and minimal curves.

Few points in this book call for adverse criticism. In determining the motion of the frame consisting of tangent, normal and binormal at any point of a curve, it would be clearer to introduce the curvature and torsion into the general formulæ for moving axes as measures of small rotations, and it would be more convenient to make a positive torsion correspond to a positive rotation (in this connection the English reader may be warned that the term "rechts-gewunden" is applied to what we should call a "left-handed" screw). It is surprising that no general method is given for expanding the coordinates in powers of the arc; the employment of these expansions very much simplifies the investigation of osculating helices and of the osculating cone, and can hardly be objected to on the ground of being a "Kunstgriff."

The book is written in a very pleasing style, with that light and clear touch which we are accustomed to associate with French writers, and except in one or two instances the analysis is very judiciously handled. For soundness it leaves nothing to be desired and its incompleteness is only an incentive to deeper research into the subject. Specially commendable are the careful explanations of points which are usually slurred over. A distinct feature is the introduction of imaginary quantities at an early stage and the discussion of exceptional cases that arise in connection with minimal lines and curves. The whole book is pervaded by the ideas which are associated with the name of the author's great master, Sophus Lie.

The type is clear and good, misprints seldom occur, and the figures are excellent. The practice of giving two or three orthogonal projections instead of one figure in perspective is much to be commended as a means of conveying exact information and of training the student to build up a mental conception of a figure in three dimensions.

The second volume, which is promised in the course of next year, will be awaited with the greatest interest.

R. W. H. T. H.

#### OUR BOOK SHELF.

*Les Phénomènes électriques et leurs Applications.* By H. Vivarez. Pp. vi + 574. (Paris: Carré and Naud, 1901.) Price Fr. 15.

M. VIVAREZ'S book covers almost the whole field of modern electrical practice in a manner which is neither too technical nor too popular. The daily increasing applications of electricity in the industries and arts render such a book valuable in two ways. In the first place, it should appeal to the ordinary engineer, manufacturer or man of science who finds himself obliged to make use of electricity in some way or other, and who can turn to its pages for general information on the subject. Secondly, the electrical engineer is generally obliged nowadays to become a specialist in some particular branch of his profession, and is liable, in consequence, to get out of touch with other branches with which it is desirable he should have a general, if not a detailed, acquaintance. Such he can obtain from a book of this kind. M. Vivarez has set out with the object of supplying the wants of these persons, and also, doubtless, the want of the intelligent amateur who is anxious to keep pace with modern industrial progress, and he has, we think, succeeded admirably in his endeavour. He has produced a book which is thoroughly readable and interesting, and is not at all overlaid with calculation or

technical detail. Perhaps in some cases he has shown rather a tendency to skip over the less interesting parts at a sacrifice of clearness, as, for example, in the section on units. This may not be of much importance to the electrician who will have obtained his fundamental conceptions elsewhere, but it is a great disadvantage to the non-electrical reader, who can never properly understand the subject unless his knowledge of the groundwork be sound—a truth he is himself too prone to ignore.

In a book of this kind a great deal depends on the proper proportioning of the space allotted to the various subjects considered. On the whole, M. Vivarez has divided his space very fairly, though he has given rather an undue preponderance to the more modern "engineering" developments. More space should, we think, have been devoted to telegraphy, which is at once the oldest and the most important application of electricity; electrochemistry and metallurgy are also treated somewhat too briefly. We looked in vain, also, for any description of vacuum tubes; their omission is unfortunate, seeing of what value they have become to mankind since Röntgen's discovery. The X-ray may have passed rather from the hands of the electrician to those of the surgeon, but it remains, all the same, an important "phénomène électrique."

The most interesting portions of the book, to our mind, are the historical parts. M. Vivarez has given a brief historical account of all the important developments, and has carried this to the extent of even giving a short history of the industrial employment of coal. These historical summaries are both interesting and valuable, the more so as this is a side of science too frequently neglected. Is it because the development is so rapid that the history cannot keep pace with it, or, as we are inclined to believe, because of the natural antipathy of the average engineer to anything that tends to be literary? In any case, there can be no doubt that many engineers will be found ignorant, not only of the works, but even of the names of the men who have made their profession, and for this reason we would recommend the book before us to the student of electrical engineering; it will show him the importance of the work of the man of science, and may bear useful fruit in inducing him to read original papers.

*The Agricultural Changes and Laying Down Land to Grass.* By R. H. Elliott, 2nd edition. Pp. xii + 101. (Kelso: J. and J. H. Rutherford, 1901.)

MR. ELLIOTT has for some years been pursuing a system of agriculture on his estate in Roxburgh, the essential feature of which is that he secures a thick turf by the use of heavy seedlings of the stronger grasses and other pasture plants, and after half a dozen years or so humus has accumulated to such an extent that the land may be put through a course of tillage cultivation without the use of any fertiliser but artificial manures. The seed-mixture that he uses is characterised not only by its abundance, but also by the fact that it contains the seeds of such out-of-the-way plants as burnet and chicory. Mr. Elliott is a firm believer in the ameliorative influence of deep roots on the subsoil, and certainly his pastures yield a large amount of food. He claims that the temporary leys secured under his system are much more profitable than "our two great enemies, turnips and cereals," and our national statistics show that many farmers are of the same opinion. The system has, no doubt, answered well in the comparatively cool and humid atmosphere of the Cheviot uplands, but whether it is capable of successful adoption in the drier districts of England is another matter. As Mr. Elliott has not put his system into competition with the ordinary methods of management of temporary grass land, it is impossible to say whether it is an improvement on general practice or not. Be this as it may, it does not